

R309. Environmental Quality, Drinking Water.**R309-530. Facility Design and Operation: Alternative Surface Water Treatment Methods.****R309-530-1. Purpose.**

This rule specifies requirements for alternative surface water treatment methods. It is intended to be applied in conjunction with rules R309-500 through R309-550. Collectively, these rules govern the design, construction, operation and maintenance of public drinking water system facilities. These rules are intended to assure that such facilities are reliably capable of supplying adequate quantities of water which consistently meet applicable drinking water quality requirements and do not pose a threat to general public health.

R309-530-2. Authority.

This rule is promulgated by the Drinking Water Board as authorized by Title 19, Environmental Quality Code, Chapter 4, Safe Drinking Water Act, Subsection 104(1)(a)(ii) of the Utah Code and in accordance with Title 63G, Chapter 3 of the same, known as the Administrative Rulemaking Act.

R309-530-3. Definitions.

Definitions for certain terms used in this rule are given in R309-110 but may be further clarified herein.

R309-530-4. General.

(1) Alternative Methods. In addition to conventional surface water treatment, coagulation, sedimentation, and filtration as outlined in Rule R309-525, several alternative filtration methods may be suitable for treating surface water. They are direct filtration, slow sand filtration, membrane filtration, and diatomaceous earth filtration.

(2) Incorporation of Other Rules. The following requirements are incorporated into Sections R309-530-5 through R309-530-9 for alternative surface water treatment methods.

- (a) Plant Siting, Section R309-525-6.
- (b) Pre-design Submittal, Subsection R309-515-5(2).
- (c) Plant Reliability, Section R309-525-7.
- (d) Color Coding and Pipe Marking, Section R309-525-8.
- (e) Chemical Addition, Section R309-525-11.
- (f) Miscellaneous Plant Facilities, Section R309-525-17, Subsection R309-525-17(1), Laboratory.
- (g) Operation and Maintenance Manuals, Section R309-525-19.
- (h) Safety, Section R309-525-21.
- (i) Disposal of Treatment Plant Waste, Section R309-525-23.
- (j) Disinfection, Rule R309-520.
- (3) Source Water Quality Data.

(a) A water supplier proposing to use alternative filtration to treat surface water or groundwater under the direct influence of surface water shall obtain sufficient source water quality data to:

- (i) determine the feasibility of alternative filtration treatment;
- (ii) identify substances that may affect the alternative filtration process and finished water quality;
- (iii) estimate productivity of the alternative filtration process; and
- (iv) determine if seasonal variation is substantial enough to affect design.

(b) Source water quality data required by Subsection R309-530-4(3) shall be collected no more than two years prior to the date that plans and specifications for a treatment facility are submitted to the division.

(c) The source water quality data for alternative filtration shall include at least:

- (i) one round of sampling for the contaminants required for initial analysis by Subsection R309-515-4(5); and
- (ii) four quarters of sampling collected over a period of 12 months for:
 - (A) alkalinity;
 - (B) pH;
 - (C) temperature;
 - (D) total organic carbon;
 - (E) total suspended solids;
 - (F) turbidity; and
 - (G) any additional parameter needed to design the treatment facility as determined by consultation with the division.

(d) No later than the date that plans and specifications for an alternative filtration facility are submitted to the division, a water supplier shall also submit:

- (i) a summary of source water quality data used to design the facility; and
- (ii) a description of how the source water quality data address items (i) through (iv) of Subsection R309-530-4(3)(a).

R309-530-5. Direct Filtration.

(1) Chemical Addition and Mixing.

Direct Filtration is conventional surface water treatment without the sedimentation process. Rules for Chemical Addition and Mixing shall be the same as found in sections R309-525-11 and R309-525-12.

(2) Source Water Quality.

Direct Filtration applies the destabilized colloids to the filter rather than removing the majority of the load through sedimentation. While this process represents considerable construction cost savings, the source water must have low average turbidity in order to provide reliable service without excessive backwash requirements. Source water with low average turbidity is generally only obtained from large capacity reservoirs.

(3) Design Requirements.

The following requirements shall apply to Direct Filtration plants:

(a) At least one year's record of source water turbidity, sampled at least once per week, shall be presented to the Director. A Direct Filtration facility will only be permitted if the data shows that 75% of the measurements are below five (5) NTU. The Director shall judge whether Direct Filtration is suitable given the quality of the proposed source water (see R309-515-5(2)(a)(ii)).

(b) Pilot plant studies, acceptable to the Director, shall be conducted prior to the preparation of final engineering plans.

(c) Requirements for flash mix and flocculation basin design are given in sub-sections R309-525-12(1) and R309-525-12(2).

(d) Chemical addition and mixing equipment shall be designed to be capable of providing a visible, but not necessarily settleable, floc.

(e) Surface wash, subsurface wash, or air scour shall be provided for the filters in accordance with sub-section R309-525-15(7).

(f) A continuous monitoring turbidimeter shall be installed on each filter effluent line and shall be of a type with at least two alarm conditions capable of meeting the requirements of subsections R309-525-15(4)(b)(vi) or R309-525-15(4)(c)(vii). The combined plant effluent shall be equipped with a continuous turbidimeter having a chart recorder. Additional monitoring equipment to assist in control of the coagulant dose may be required (i.e. streaming current gauges, particle counters, etc.) if the plant cannot consistently meet the requirements of rule R309-200.

(g) In addition to the alarm conditions required above, the plant shall be designed and operated so that the plant will automatically shut down when a source water turbidity of 20 NTU lasts longer than three hours, or when the source water turbidity exceeds 30 NTU at any time.

(h) The plant design and land ownership surrounding the plant shall allow for the installation of conventional sedimentation basins. Sedimentation basins may be required if the Director determines the plant is failing to meet minimum water quality or performance standards.

R309-530-6. Slow Sand Filtration.

(1) Acceptability.

Slow sand filtration means a process involving passage of raw water through a bed of sand at low velocity resulting in substantial particle removal by physical and biological mechanisms. The acceptability of slow sand filters as a substitute for "conventional surface water treatment" facilities (detailed in R309-525) shall be determined by the Director based on suitability of the source water and demand characteristics of the system.

(2) Source Water Quality.

The Director may impose design requirements in addition to those listed herein, in allowing this process. The following shall be considered, among other factors, in determining whether slow sand filtration will be acceptable:

(a) Source water turbidity must be low and consistent. Slow Sand Filtration shall be utilized only when the source waters have turbidity less than 50 NTU and color less than 30 units (see R309-515-5(2)(a)).

(b) The nature of the turbidity particles shall be considered. Turbidity must not be attributable to colloidal clay.

(c) The nature and extent of algae growths in the raw water shall be considered. Algae must not be a species considered as filter and screen-clogging algae as indicated in "Standard Methods for the Examination of Water and Wastewater" prepared and published jointly by American Public Health Association, American Water Works Association, and Water Environment Federation. High concentrations of algae in the raw water can cause short filter runs; the amount of algae, expressed as the concentration of chlorophyll "a" in the raw water shall not exceed 0.005 mg/l.

(3) Pilot Plant Studies.

The Director shall allow the use of Slow Sand Filtration only when the supplier's engineering studies show that the slow sand facility can consistently produce an effluent meeting the quality requirements of rule R309-200. The Director should be consulted prior to the detailed design of a slow sand facility.

(4) Operation.

Effluent from a Slow Sand Filtration facility shall not be introduced into a public water supply until an active biological mat has been created on the filter.

(5) Design requirements.

The following design parameters shall apply to each Slow Sand Filtration plant:

(a) At least three filter units shall be provided. Where only three units are provided, any two shall be capable of meeting the plant's design capacity (normally the projected "peak daily flow") at the approved filtration rate. Where more than three filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with any one filter removed from service.

(b) All filters shall be protected to prevent freezing. If covered by a structure, enough headroom shall exist to permit normal movement by operating personnel for scraping and sand removal operations. There shall be adequate manholes and access ports for the handling of sand. An overflow at the maximum filter water level shall be provided.

(c) The permissible rates of filtration shall be determined by the quality of the source water and shall be determined by experimental data derived during pilot studies conducted on the source water. Filtration rates of 0.03 gpm/sf to 0.1 gpm/sf shall be

acceptable (equivalent to two to six million gallons per day per acre). Somewhat higher rates may be acceptable when demonstrated to the satisfaction of the Director.

(d) Each filter unit shall be equipped with a main drain and an adequate number of lateral underdrains to collect the filtered water. The underdrains shall be so spaced that the maximum velocity of the water flow in the underdrain will not exceed 0.75 fps. The maximum spacing of the laterals shall not exceed three feet if pipe laterals are used.

(e) Filter sand shall be placed on graded gravel layers for an initial filter sand depth of 30 inches. A minimum of 24 inches of filter sand shall be present, even after scraping. The effective size of the filter sand shall be between 0.30 mm and 0.45 mm in diameter. The filter sand uniformity coefficient shall not exceed 2.5. Further, the sand shall thoroughly washed and found to be clean and free from foreign matter.

(f) A three-inch layer of well rounded sand shall be used as a supporting media for filter sand. It shall have an effective size of 0.8 mm to 2.0 mm in diameter and the uniformity coefficient shall not be greater than 1.7.

(g) A supporting gravel media shall be provided. It shall consist of hard, durable, rounded silica particles and shall not include flat or elongated particles. The coarsest gravel shall be 2.5 inches in size when the gravel rests directly on the strainer system, and must extend above the top of the perforated laterals. Not less than four layers of gravel shall be provided in accordance with the following size and depth distribution when used with perforated laterals:

TABLE 530-1

Size	Depth
2 1/2 to 1 1/2 inches	5 to 8 inches
1 1/2 to 3/4 inches	3 to 5 inches
3/4 to 1/2 inches	3 to 5 inches
1/2 to 3/16 inches	2 to 3 inches
3/16 to 3/32 inches	2 to 3 inches

Reduction of gravel depths may be considered upon justification to the Director when proprietary filter bottoms are specified.

(h) Slow sand filters shall be designed to provide a depth of at least three to five feet of water over the sand.

(i) Each filter shall be equipped with: a loss of head gauge; an orifice, venturi meter, or other suitable metering device installed on each filter to control the rate of filtration; and an effluent pipe designed to maintain the water level above the top of the filter sand.

(j) Disinfection of the effluent of Slow Sand Filtration plants will be required.

(k) A filter-to-waste provision shall be included.

(l) Electrical power shall be available at the plant site.

R309-530-7. Diatomaceous Earth Filtration.

The use of Diatomaceous Earth Filtration units may be considered for application to surface waters with low turbidity and low bacterial contamination, and additionally may be used for iron removal for groundwaters of low quality, providing the removal is effective and the water is of sanitary quality before treatment.

The acceptability of Diatomaceous Earth Filtration as a substitute for "conventional surface water treatment" facilities (detailed in rule R309-525) shall be determined by the Director. Determination may be based on the level of support previously exhibited by the public water system management along with a finding by the Director that "conventional surface water treatment" or other methods herein described are too costly or unacceptable.

Diatomaceous Earth Filtration consists of a process to remove particles from water wherein a precoat cake of diatomaceous earth filter media is deposited on a support membrane (septum), and while the water is filtered by passing through the cake on the septum, additional filter media known as body feed is continuously added to the source water to maintain the permeability of the filter cake. Diatomite filters are characterized by rigorous operating requirements, high operating costs, and increased sludge production.

Part 4, Section 4.2.3, Diatomaceous Earth Filtration, in the Recommended Standards for Water Works (commonly known as "Ten State Standards"), 2007 edition is hereby incorporated by reference and compliance with those standards shall be required for the design and operation of diatomaceous earth filtration facilities. This document is published by the Great Lakes-Upper Mississippi River Board of Public Health and Environmental Managers. A copy is available in the office of the Division for reference.

R309-530-8. Membrane Filtration.

(1) Definitions.

(a) "Backwash" means the cleaning operation that typically involves periodic reverse flow to remove foulants accumulated at the membrane surface or the intermittent waste stream from a microfiltration or ultrafiltration membrane system.

(b) "Baseline Response" means the amount of airflow or pressure decay due to diffusion of air through water in wetted pores or membrane material in an integral membrane unit.

(c) "Challenge Test" means a study conducted to determine the removal efficiency, known as the log removal value, of a membrane material for a particular organism, particulate, or surrogate.

(d) "Chemically Enhanced Backwash" means a backwash process that includes the addition of chemicals to reduce or remove membrane foulants.

(e) "Clean-in-Place (CIP)" means the periodic application of a chemical solution, or series of chemical solutions, to a

membrane unit for the intended purpose of removing accumulated foulants and thus restoring permeability and resistance to baseline levels; commonly used term for in-situ chemical cleaning.

(f) “Concentrate” means the continuous waste stream, typically consisting of concentrated dissolved solids, from a membrane process, usually in association with nanofiltration and reverse osmosis processes; in some cases, also used to describe a continuous bleed stream of concentrated suspended solids wasted from microfiltration and ultrafiltration systems operated in a crossflow, or feed-and-bleed, hydraulic configuration.

(g) “Control Limit” means a response from an integrity test, which, if exceeded, indicates a potential problem with the membrane filtration system and triggers a response; synonymous with “upper control limit” as used in the United States Environmental Protection Agency’s Membrane Filtration Guidance Manual, EPA 815-R-06-009, to distinguish from additional voluntary or State-mandated “lower control limits.”

(h) “Differential Pressure” means pressure drop across a membrane module or unit from the feed inlet to concentrate outlet, as distinguished from transmembrane pressure, which represents the pressure drop across the membrane barrier.

(i) “Direct Integrity Test (DIT)” means a physical test applied to a membrane unit to identify and isolate integrity breaches.

(j) “Feedwater” means the influent stream to a water treatment process.

(k) “Filtrate” means the water produced from a membrane filtration unit.

(l) “Foulant” means a substance that causes fouling.

(m) “Fouling” means the gradual accumulation of contaminants on a membrane surface or within a porous membrane structure that inhibits the passage of water, thus decreasing productivity.

(n) “Flux” means the filtration rate of a membrane filtration system expressed as flow per unit of membrane area, such as gallons per square foot per day.

(o) “Indirect Integrity Monitoring” means monitoring some aspect of filtrate water quality that is indicative of the removal of particulate matter.

(p) “Log Removal Value (LRV)” means the filtration removal efficiency for a target organism, particulate, or surrogate expressed as \log_{10} ; $LRV = \log_{10}(\text{feed concentration}) - \log_{10}(\text{filtrate concentration})$.

(q) “Maintenance Clean” means a routine, short-duration chemical cleaning to minimize the accumulation of foulants.

(r) “Membrane Unit” means a group of membrane modules that share common valving that allows the unit to be isolated from the rest of the system for integrity testing or other maintenance.

(s) “Membrane Module” means the smallest component of a membrane unit in which a specific membrane surface area is housed in a device with a filtrate outlet structure.

(t) “Normalized Flux” means the filtration rate of a membrane filtration system expressed as flow per unit of membrane area, such as gallons per square foot per day, at a given reference temperature for monitoring system productivity independent of changes in water temperature. For microfiltration, ultrafiltration, and membrane cartridge filtration, 20 degrees Celsius is used for normalization. For nanofiltration and reverse osmosis, 25 degrees Celsius is used for normalization.

(u) “Productivity” means the amount of filtered water that can be produced from a membrane module, filtration unit, or system over a period of time, accounting for the use of filtrate in backwash and chemical cleaning operations, as well as otherwise productive time that a unit or system is offline for routine maintenance processes such as backwashing, chemical cleaning, integrity testing, or repair.

(v) “Recovery” means the volumetric percent of feedwater that is converted to filtrate in the treatment process over the course of an operating cycle uninterrupted by chemical cleaning or a solids-removal process such as backwashing and excluding losses that occur due to the use of filtrate in backwashing or cleaning operations.

(w) “Resolution” means the size of the smallest integrity breach that contributes to a response from a DIT; also applicable to some indirect integrity monitoring methods.

(x) “Sensitivity” means the maximum LRV that can be reliably verified by a DIT; also applicable to some continuous indirect integrity monitoring methods.

(y) “Transmembrane Pressure (TMP)” means the difference in pressure from the feed, or feed-concentrate average, if applicable, to the filtrate across a membrane barrier.

(2) Applicability. The requirements of Section R309-530-8 apply to membrane filtration used to treat surface water or groundwater under the direct influence of surface water to:

(a) obtain LRV credit for Giardia, Cryptosporidium, and viruses;

(b) meet the turbidity treatment technique requirements of Rule R309-200; or

(c) meet the filtration treatment technique requirements for enhanced treatment for Cryptosporidium of Section R309-

215-15.

(3) Turbidity Treatment Technique and Performance Requirements.

(a) The turbidity treatment technique and turbidity performance requirements for a water system using membrane filtration to treat surface water or groundwater under the direct influence of surface water are specified in Subsection R309-200-5(5)(a)(ii).

(b) To receive log removal credit for Giardia, Cryptosporidium, or viruses under Subsection R309-200-5(5)(a)(ii), a membrane shall:

- (i) meet the definition of membrane filtration in Rule R309-110;
- (ii) be capable of establishing removal efficiency through product-specific challenge testing and direct integrity testing;

and

- (iii) undergo direct integrity testing and continuous indirect integrity monitoring during operation.

(4) Challenge Testing of Membrane Modules and LRV Credit.

(a) A membrane module proposed for treatment of surface water or groundwater under the direct influence of surface water shall:

(i) undergo product-specific challenge testing meeting the requirements of Subsection R309-215-15(18)(b)(ii) to evaluate the membrane's removal efficiency; and

(ii) either have NSF/ANSI 419 certification or be accepted by a state with a public drinking water program approved by U.S. EPA.

(b) A water supplier shall submit challenge test results for a proposed membrane module to the division for review prior to pilot testing and facility design.

(c) The division shall award a maximum LRV credit for Giardia, Cryptosporidium, and viruses to a membrane module proposed by a water supplier to be used for design of a membrane filtration facility.

(d) A water supplier shall verify an LRV credit awarded to a membrane module by direct integrity testing meeting the requirements of Subsection R309-215-15(18)(b)(iii) during normal operation of a constructed membrane filtration facility.

(5) Pilot Test or Comparable Full-Scale Membrane Filtration Operational Data. Prior to design of a membrane filtration facility, a water supplier shall:

(a) complete a pilot test of a proposed membrane module; or

(b) request and receive approval from the division to use comparable operational data from a full-scale membrane facility treating water of the same or similar quality for a proposed membrane module.

(6) Pilot Test Protocol.

(a) Prior to initiating a pilot test, a water supplier shall:

- (i) submit a test protocol to the division for review; and
- (ii) receive written concurrence with the protocol from the division.

(b) The pilot test protocol shall specify the:

- (i) source of water for the test;
- (ii) membrane module selected for the test;
- (iii) number of membrane modules to be tested for the full duration of the pilot test;
- (iv) test duration, including number of clean-in-place cycles;
- (v) time of year to perform the test;
- (vi) objectives of the test, including operating procedures to analyze the optimal balance among:
 - (A) flux;
 - (B) productivity;
 - (C) backwash frequency;
 - (D) maintenance-clean frequency; and
 - (E) clean-in-place frequency;
- (vii) hydraulic configuration to match the full-scale system;
- (viii) continuous operational parameter monitoring for each filter run, including:
 - (A) elapsed run time;
 - (B) feedwater, filtrate, and concentrate pressure;
 - (C) feedwater, filtrate, and concentrate flow; and
 - (D) feedwater or filtrate temperature;
- (ix) water quality monitoring of the feedwater, filtrate, and concentrate, including:
 - (A) parameters to be sampled; and
 - (B) frequency of sample collection;
- (x) backwash process, including chemical enhancement, and data collection;
- (xi) maintenance-clean process;

- (xii) clean-in-place process, including:
 - (A) data collection; and
 - (B) direct integrity testing prior to returning the pilot unit to service;
- (xiii) direct integrity testing process and data collection;
- (xiv) indirect integrity monitoring process and data collection;
- (xv) prescreening to protect membrane plugging or damage;
- (xvi) pretreatment required for membrane treatment efficiency and removal of substances not removed by membrane treatment;
- (xvii) post-treatment required; and
- (xviii) waste disposal.
- (7) Preliminary Design Report.
 - (a) Prior to submitting plans and specifications to the division, a water supplier proposing a new or modified membrane filtration facility shall:
 - (i) submit a preliminary design report to the division that establishes design parameters for a full-scale membrane filtration facility that meets the requirements of Section R309-530-8; and
 - (ii) receive written concurrence with the report from the division.
 - (b) The preliminary design report shall include:
 - (i) a summary of pilot test results or comparable full-scale membrane operational data addressing each of the items listed in Subsection R309-530-8(6), Pilot Test Protocol;
 - (ii) preliminary design specifications for membrane filtration, including:
 - (A) flux operating range;
 - (B) differential pressure operating range;
 - (C) recovery;
 - (D) productivity;
 - (E) membrane fouling potential based on pilot test results;
 - (F) membrane removal efficiency, LRV, verified during the pilot test;
 - (G) total membrane area per module; and
 - (H) number of membrane modules for the full-scale facility.
 - (iii) treatment objectives based on source water quality, including:
 - (A) potential of the treated water to produce disinfection byproducts when chlorine is added for disinfection prior to distribution; and
 - (B) potential of the filtration process to produce corrosive water and the need for chemical conditioning of the filtrate prior to distribution;
 - (iv) design capacity and its basis;
 - (v) mode of filtration operation – constant flux or constant pressure;
 - (vi) expected useful life of selected membranes;
 - (vii) identification of critical components to be provided in duplicate to assure continued operation of membrane filtration in the case of a component failure;
 - (viii) details of direct integrity testing representative of an integral membrane filtration unit, including:
 - (A) description of the testing procedure;
 - (B) method of direct integrity testing meeting the requirements of Subsection R309-215-15(18)(b)(iii);
 - (C) frequency of testing meeting the requirements of Subsection R309-215-15(18)(b)(iii)(F);
 - (D) estimated test resolution meeting the requirements of Subsection R309-215-15(18)(b)(iii)(B);
 - (E) estimated test sensitivity meeting the requirements of Subsection R309-215-15(18)(b)(iii)(C);
 - (F) for pressure-based testing, calculations that demonstrate how the measured pressure or flow is converted to an equivalent LRV;
 - (G) for marker-based testing, identification of:
 - (I) the particulate or molecular marker; and
 - (II) how the marker will be discretely quantified or measured;
 - (H) estimated control limit meeting the requirements of Subsections R309-215-15(18)(b)(iii)(D) and (E); and
 - (I) for pressure-based testing, a baseline response if applicable, and how it was determined.
 - (ix) details of continuous indirect integrity monitoring of filtrate quality from each membrane filtration unit, including:
 - (A) description of the monitoring procedure;
 - (B) method of continuous indirect integrity monitoring meeting the requirements of Subsection R309-215-

15(18)(b)(iv);

(C) frequency of monitoring meeting the requirements of Subsection R309-215-15(18)(b)(iv)(B);

(D) estimated performance-based control limit meeting the requirements of Subsection R309-215-15(18)(b)(iv)(D) or

(E); and

(E) triggers for initiating a DIT meeting the requirements of Subsection R309-215-15(18)(b)(iv)(D) or (E);

(x) details of the backwashing process and chemically enhanced backwashing process for membranes requiring backwashing, including:

(A) triggers for initiating the processes;

(B) backwashing and chemically enhanced backwashing frequencies;

(C) duration of processes;

(D) water supply for backwashing;

(E) chemical supply for enhanced backwashing;

(F) list of chemicals used for chemically enhanced backwashing;

(G) treatment and disposal of backwash water and chemicals at completion of the processes;

(H) backwash-water recycling; and

(I) description of cross-connection control for the chemically enhanced backwashing process;

(xi) details of the maintenance-clean process and the clean-in-place process for membranes requiring chemical cleaning, including:

(A) triggers for initiating the process;

(B) process frequency;

(C) chemical supply for the process;

(D) list of chemicals used in the cleaning process;

(E) heating requirements for the cleaning solution;

(F) cleaning-solution recirculation;

(G) soak cycle;

(H) chemical recycling;

(I) post-CIP process for verification that the chemical concentration was adequate for the cleaning cycle;

(J) post-cleaning requirements for returning a membrane unit to filtration, including:

(I) backwashing or flushing;

(II) direct integrity testing; and

(III) disposal of chemical waste stream and rinse water; and

(K) description of cross-connection control for the process.

(8) Design Criteria.

(a) See Subsection R309-530-4(3) for source water quality data collection and submission requirements that a water supplier shall meet no later than the date that plans and specifications are submitted to the division.

(b) Treatment Capacity of a Membrane Filtration Facility.

(i) A membrane filtration facility that provides the sole source of water to a water system shall be capable of meeting peak day demand at the lowest feedwater temperature when the largest membrane unit is out of service by providing either:

(A) one redundant membrane unit; or

(B) multiple membrane units with excess treatment capacity for each unit at maximum design flux.

(ii) A membrane filtration facility that provides the sole source of water to a noncommunity water system that can discontinue water service and shut down does not have to be capable of meeting peak day demand when the largest membrane unit is out of service.

(iii) The treatment capacity of a membrane filtration facility shall account for the:

(A) use of filtrate for backwashing and chemical cleaning;

(B) loss of concentrate; and

(C) loss of filtrate from flushing membranes after chemical cleaning.

(c) Redundancy of Critical Components.

(i) A membrane filtration facility that provides the sole source of water to a water system shall provide critical components needed to maintain continuous operation of the filtration process, as identified in the preliminary design report, in duplicate.

(ii) A membrane filtration facility that provides the sole source of water to a noncommunity water system that can discontinue water service and shut down does not have to provide critical components in duplicate.

(d) Certification of Chemicals and Components.

(i) Chemicals added during water treatment, including chemicals used to clean membrane modules and associated piping, shall be certified to meet NSF/ANSI 60.

(ii) Materials in contact with water during or following the treatment process, including membrane filtration modules and membrane repair materials, shall be certified to meet NSF/ANSI 61.

(e) Membrane Facility Housing. A membrane filtration facility shall be housed in a structure that is:

(i) weatherproof;

(ii) accessible at times that the facility is active;

(iii) protected from flooding;

(iv) drained to prevent the accumulation of water on the floor;

(v) locked and secured to prevent vandalism and unauthorized entry;

(vi) heated, cooled, and vented to protect the equipment;

(vii) dehumidified, if necessary, to protect the equipment;

(viii) lighted to allow routine operation and maintenance; and

(ix) sized and configured to allow operation and maintenance, including the removal and replacement of membrane equipment.

(f) Prefiltration Screening and Pretreatment. Prefiltration screening and pretreatment shall be provided based on source water quality, pilot testing, and preliminary design report recommendations.

(i) Prefiltration screening shall remove particles and debris that may damage or plug a membrane.

(ii) Chemicals used in pretreatment shall be compatible with the membrane material.

(iii) A pretreatment process that uses a polymer upstream of a membrane shall minimize or eliminate polymer carryover to the membrane.

(iv) Equipment shall be provided for routine testing of the effectiveness of the pretreatment process.

(g) Post-treatment. Post-treatment for membrane filtration shall be provided based on pilot testing or preliminary design report recommendations.

(i) Equipment shall be provided for:

(A) routine testing of the effectiveness of the post-treatment process; and

(B) compliance monitoring required by drinking water rules.

(ii) Requirements for disinfection following membrane filtration are specified in Rules R309-200, R309-210, R309-215, and R309-520.

(h) Bypass Water Handling.

(i) Untreated surface water or groundwater under the direct influence of surface water may not bypass the membrane filtration process.

(ii) Water blended with filtrate from membrane filtration treatment prior to distribution shall meet drinking water standards.

(i) Filter-to-Waste. Each membrane unit shall be equipped to allow filtrate to be sent to waste instead of distribution.

(j) Waste Disposal. Waste generated by membrane filtration, including concentrate, filter-to-waste water, backwash water, and spent membrane-cleaning solution, shall be disposed of according to applicable regulations.

(k) Backwashing Equipment.

(i) For membranes that require backwashing, backwashing equipment shall be provided to remove accumulated foulants from the membrane surface.

(ii) Piping and pumps shall be compatible with chemicals used for chemically enhanced backwashing.

(iii) Air provided during backwashing shall be:

(A) filtered;

(B) dry; and

(C) oil free.

(iv) If water from backwashing is recycled, it shall be:

(A) treated to remove solids; and

(B) returned to the head of the treatment facility.

(v) To prevent damage to a membrane or its housing, for automatic backwashing, a backwash pump shall be equipped with:

(A) a variable frequency drive;

(B) soft start and stop capabilities; or

(C) slow opening and closing automatic valves.

(vi) A means shall be provided to measure the total flow and the rate of flow of the backwash water during the

backwashing process.

- (vii) Filtrate shall be:
 - (A) used to backwash membrane modules or membrane units; and
 - (B) supplied in sufficient volume to maintain rated plant capacity.
- (l) Clean-in-Place and Maintenance-Clean Equipment.
 - (i) For membranes that require chemical cleaning, equipment shall be provided to remove accumulated foulants on the membrane surface not removed by backwashing.
 - (ii) Piping and pumps shall be compatible with the chemicals used for cleaning.
 - (iii) Equipment for chemical cleaning shall be provided with cross-connection control to isolate chemicals from the feedwater and filtrate during the cleaning process.
 - (iv) Secondary containment for leaks and spills from a chemical storage tank shall be provided to:
 - (A) protect the operator and equipment; and
 - (B) prevent release of chemicals to the environment.
 - (m) Direct Integrity Testing Equipment.
 - (i) Equipment shall be provided for automatic direct integrity testing of each membrane unit to:
 - (A) detect potential breaches; and
 - (B) record test results.
 - (ii) Equipment shall be capable of applying direct integrity testing to physical elements of the membrane unit, including:
 - (A) membranes;
 - (B) seals;
 - (C) potting material;
 - (D) valves;
 - (E) piping; and
 - (F) any other component that could result in contamination of the filtrate if the component's integrity were compromised.
 - (iii) Air provided for pressure-based testing shall be:
 - (A) filtered;
 - (B) dry; and
 - (C) oil free.
 - (iv) A particle used for marker-based testing shall:
 - (A) be certified to meet NSF/ANSI 60;
 - (B) be inert;
 - (C) be compatible with the membrane material;
 - (D) have an effective size of 3 μm or less;
 - (E) have a neutral surface charge;
 - (F) be capable of being discretely measured; and
 - (G) be removed less efficiently than the organism targeted for treatment by membrane filtration.
 - (v) A molecule used for marker-based testing shall:
 - (A) be capable of being discretely quantified; and
 - (B) have an effective size equivalent to 3 μm or less.
 - (n) Indirect Integrity Monitoring Equipment. Equipment shall be provided for the continuous monitoring and recording of turbidity levels of the filtrate at each membrane unit as specified in Subsection R309-530-8(8)(s).
 - (o) Sample Collection. A means to collect samples shall be provided for the:
 - (i) raw-water inlet to a membrane filtration facility;
 - (ii) feedwater inlet to a membrane unit;
 - (iii) filtrate outlet from a membrane unit;
 - (iv) concentrate outlet;
 - (v) combined-filter outlet;
 - (vi) finished-water outlet from a membrane filtration facility;
 - (vii) water supply for membrane backwashing; and
 - (viii) clean-in-place chemical solution.
 - (p) Flow Measurement. A means to measure and record the total flow and the rate of flow shall be provided for the:
 - (i) raw-water inlet to a membrane filtration facility;
 - (ii) feedwater inlet to a membrane unit;

- (iii) filtrate outlet from a membrane unit;
- (iv) concentrate outlet;
- (v) finished-water outlet from a membrane filtration facility;
- (vi) water supply for membrane backwashing; and
- (vii) recycled water.
- (q) pH and Temperature Measurement. A means to measure and record pH and temperature shall be provided for the:
 - (i) raw-water inlet to a membrane filtration facility; and
 - (ii) finished-water outlet from a membrane filtration facility.
- (r) Pressure Measurement. A means to measure and record pressure for a membrane filtration unit shall be provided for

the:

- (i) feedwater inlet;
- (ii) concentrate outlet; and
- (iii) filtrate outlet.
- (s) Turbidity Measurement. A means to measure and record turbidity shall be provided for the:
 - (i) raw-water inlet to a membrane filtration facility;
 - (ii) outlet from a pretreatment process;
 - (iii) filtrate outlet from a membrane unit;
 - (iv) combined-filter outlet;
 - (v) outlet from any other process downstream of membrane filtration that may increase turbidity; and
 - (vi) clearwell outlet as required by Subsection R309-215-9(1)(a).
- (t) Cross-Connection Control. Cross-connection control shall be provided to prevent contamination of feedwater and filtrate from cleaning chemicals and waste disposal.
- (u) System Controls.
 - (i) System controls for a membrane filtration facility shall be:
 - (A) located above ground;
 - (B) protected from flooding; and
 - (C) capable of automatically shutting down the membrane filtration process to prevent damage to the membranes or distribution of inadequately treated drinking water.
 - (ii) Automated system controls shall be provided with:
 - (A) spare input/output cards of each type;
 - (B) a backup power supply; and
 - (C) surge protection.
 - (v) Alarms. A membrane filtration facility shall include an alarm system that immediately notifies a water system operator when:
 - (i) feedwater turbidity exceeds the maximum design level;
 - (ii) filtrate turbidity exceeds the level not to be exceeded at any time as specified in Subsection R309-200-5(5)(a)(ii);
 - (iii) a direct or indirect integrity test exceeds a control limit;
 - (iv) the maximum flow rate setting corresponding to the maximum design flux level is exceeded;
 - (v) TMP exceeds the maximum design level; and
 - (vi) a pump driving the filtration, backwashing, or chemical cleaning process fails.
 - (w) Control of Remote or Unoccupied Membrane Filtration Facility.
 - (i) A remote or unoccupied membrane filtration facility shall be provided with alarms, communication systems, and the ability to automatically shut down processes to prevent the distribution of inadequately treated drinking water.
 - (ii) In addition to the items listed in Subsection R309-530-8(8)(v), a remote or unoccupied membrane filtration facility shall include an alarm system that immediately notifies a water system operator of:
 - (A) failure of a critical component identified in the preliminary design report;
 - (B) failure of a programmable logic controller;
 - (C) membrane unit shutdown;
 - (D) clearwell water level above the maximum or below the minimum;
 - (E) chlorine residual level above the maximum or below the minimum;
 - (F) low level in a chemical storage tank;
 - (G) loss of electrical power;
 - (H) unauthorized entry; and
 - (I) low interior temperature of a treatment building.

- (9) Facility Startup.
 - (a) A membrane filtration facility shall be equipped to allow for disposal of feedwater and filtrate during the startup process.
 - (b) Prior to installing membrane modules:
 - (i) piping shall be flushed to remove dirt and construction debris;
 - (ii) chemical-feed equipment shall be tested to assure:
 - (A) proper operation; and
 - (B) delivery of chemicals at proper dosages;
 - (iii) mechanical equipment shall be tested for leaks and proper operation;
 - (iv) instrumentation shall be calibrated and tested for proper operation;
 - (v) the control system shall be verified for:
 - (A) digital and analog control inputs and outputs;
 - (B) instrumentation alarm limits;
 - (C) programming logic;
 - (D) instrumentation loops; and
 - (E) operational sequences.
 - (c) After installation, a membrane module shall be:
 - (i) flushed to waste to remove the storage solution; and
 - (ii) tested to assure smooth startup and shutdown.
 - (d) A water supplier shall comply with applicable disposal requirements for waste flushed from newly installed piping, tanks, equipment, and membranes at a membrane filtration facility.
 - (e) Prior to use of a membrane filtration facility to provide drinking water:
 - (i) pipes, tanks, and associated equipment shall be disinfected and flushed according to AWWA procedures;
 - (ii) membrane modules shall be disinfected and flushed according to instructions from the membrane manufacturer taking into consideration the chlorine tolerance of the membranes;
 - (iii) a facility shall be operated continuously for a trial period to verify design parameters;
 - (iv) treated water quality shall be sampled and demonstrate compliance with drinking water standards;
 - (v) final, operational control limits for direct integrity testing shall be established;
 - (vi) a DIT shall be done per Subsection R309-215-15(18)(b)(iii), and the result may not exceed the established upper control limit; and
 - (vii) a water supplier shall obtain an operating permit as required by Section R309-500-9.
 - (f) A water supplier shall assure that adequate operator training and instruction are provided by the supplier of the membrane units on each aspect of startup and operation of a membrane filtration facility.
- (10) Operating Permit – Additional Information. In addition to meeting the requirements for an operating permit in Section R309-500-9, a water supplier requesting an operating permit for a membrane filtration facility treating surface water or groundwater under the direct influence of surface water shall provide to the division:
 - (a) a statement acknowledging that the facility startup requirements of Subsection R309-530-8(9) have been completed;
 - (b) normalized operating flux range;
 - (c) normalized operating flux per membrane unit;
 - (d) maximum operating differential pressure for a membrane unit;
 - (e) membrane unit backwashing frequency;
 - (f) membrane unit clean-in-place frequency;
 - (g) minimum, verified, operational, direct integrity testing resolution;
 - (h) maximum, verified, operational, direct integrity testing sensitivity;
 - (i) verified, operational, direct integrity testing control limit; and
 - (j) verified, indirect integrity monitoring performance-based upper control limit.
- (11) Operational Membrane Integrity Testing and Monitoring and Reporting.
 - (a) Membrane Integrity Testing and Monitoring.
 - (i) Direct Integrity Testing.
 - (A) A water system using membrane filtration to treat surface water or groundwater under the direct influence of surface water to meet the requirements of Section R309-530-8 shall comply with the direct integrity testing requirements of Subsection R309-215-15(18)(b)(iii).
 - (B) A DIT shall be done on a membrane unit following:
 - (I) a clean-in-place process for a membrane unit; and

(II) repair of a membrane unit.

(C) A membrane unit that has been chemically cleaned in place or repaired may not be returned to service unless the result of a DIT of the membrane unit is at or below the established control limit.

(ii) Indirect Integrity Monitoring. A water system using membrane filtration to treat surface water or groundwater under the direct influence of surface water to meet the requirements of Section R309-530-8 shall comply with the indirect integrity monitoring requirements of Subsection R309-215-15(18)(b)(iv).

(b) Reporting Requirements for Membrane Integrity Testing. A water system using membrane filtration to treat surface water or groundwater under the direct influence of surface water to meet the requirements of Section R309-530-8 shall comply with the reporting requirements for direct integrity testing and indirect integrity monitoring of Subsection R309-215-15(20)(d)(x)(B).

(12) Membrane Replacement.

(a) A water supplier shall obtain plan approval and an operating permit for replacement of:

(i) an approved membrane module with a different module; and

(ii) an approved number of modules with a greater number of the same modules.

(b) Replacement of a membrane module with exactly the same product is considered ongoing operation and maintenance and is not a public drinking water project that requires plan approval or an operating permit.

(13) Calibration of Instrumentation. Instrumentation used to verify operation of a treatment process or determine compliance with monitoring and reporting requirements for a drinking water rule, shall be:

(a) calibrated monthly;

(b) tested for accuracy monthly; and

(c) maintained according to manufacturer's recommendations.

R309-530-9. New Treatment Processes or Equipment.

The policy of the Board is to encourage, rather than to obstruct, the development of new methods and equipment for the treatment of water. Nevertheless, any new processes or equipment must have been thoroughly tested in full-scale, comparable installations, before approval of plans can be issued.

No new treatment process will be approved for use in Utah unless the designer or supplier can present evidence satisfactory to the Director that the process will ensure the delivery of water of safe, sanitary quality, without imposing undue problems of supervision, operation, or control.

The Director shall establish the turbidity limit for 95% of turbidity measurements and the maximum turbidity limit which shall not be exceeded. The plant effluent shall meet the requirements of Subsection R309-200-5(5)(a)(ii).

KEY: drinking water, direct filtration, slow sand filtration, membrane technology

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